Exhibit 2

US7577103B2	Specification Support	NEC Small Cell LTE Gateways
1Pre. A method for improving performance in a wireless network, the method comprising:	Turning now to FIG. 3, FIG. 3 illustrates **a method for improving performance of a wireless network**, according to an example embodiment of the present invention. [Col. 5, Line 11-13]	The accused product comprises, a method for improving performance in a wireless network, the method comprising: NEC provides LTE network equipment such as LTE small cell gateway as shown in Fig. 1 and Fig. 2. **Citation 1: NEC small cell LTE Gateway** NEC provides compact, all-in-one LTE small cell gateway * For immediate use June 21, 2013  LTE Small Cell Gateway Fig. 1 Source: https://www.nec.com/en/press/201306/global_20130621_01.html, Page 1, Last accessed, May 27, 2020, Exhibit D

		Citation 2: Small Cell LTE in US **NEC First in the U.S. to Complete Small Cell LTE Interoperability Testing for Public Safety Communications Research** **Tokyo and Irving, Texas, March 4, 2013** – NEC Corporation (NEC; TSE: 6701) successfully completed interoperability testing (IOT) for the Public Safety Communications Research (PSCR) Program's 700-MHz Public Safety Demonstration Network at the Department of Commerce Boulder Laboratories in Colorado. NEC is the first vendor in the United States to successfully complete 700-MHz small cell testing. Fig. 2 Source: https://www.necam.com/press/read.cfm?ID=97025c9d-17f2-4539-a2f5-422fde50cc09, Page 1, Last accessed, Sep 9, 2020, Exhibit I The small cell LTE gateways offer connectivity for LTE small cells such as femtocells with the LTE core network and provide user plane and control plane data processing along with securely carrying the traffic to the LTE core network. NEC small cell LTE Gateways support the 3GPP self-organizing networks (SON) technology called as NEC SON. Additionally, NEC LTE Gateways with NEC-SON support multi-vendor networks and provide a method for improving performance in LTE/-LTE-Advanced networks. See Fig. 3

Citation 3: NEC Multi-Vendor SON

Tokyo & London, August 6, 2014 - NEC Corporation (NEC; TSE: 6701) announced today that it successfully completed interoperability testing of its Multi-vendor SON and Small Cell Femto Solution at the Small Cell LTE Plugfest 2. The Plugfest was held from 23 June to 2 July 2014, organised by the Small Cell Forum, in partnership with ETSI, and hosted by the Orange Labs in Paris. The Plugfest was supported by 27 companies, including equipment vendors, test tool vendors and companies providing test network infrastructure.

Fig. 3

Source: https://www.nec.com/en/press/201408/global_20140806_01.html, Page 1, Last accessed, May 27, 2020, Exhibit E

LTE/LTE-Advanced networks support self-organizing networks (SON) technology. SON technology relates to automation of various operations carried out in a telecom network. See Fig. 4

Citation 4: LTE Self-organizing Networks (SON)

4.1 SON concepts

In order to reduce the operating expenditure (OPEX) associated with the management of this larger number of nodes from more than one vendor the concept of the Self-Organizing Network (SON) is introduced. Automation of some network planning, configuration and optimisation processes via the use of SON functions can help the network operator to reduce OPEX by reducing manual involvement in such tasks.

Fig. 4

Source:https://www.etsi.org/deliver/etsi_ts/132500_132599/132500/15.00.00_60/ts_132500v150000p.pdf, Page 7, Last accessed, May 27, 2020, Exhibit A

SON solutions are divided into three categories: Self-Configuration, Self-Optimization, and Self-Healing.

		Self-Configuration allows the dynamic addition of new network elements such as eNodeB (i.e. Base station) that can be dynamically configured. Self-configuration enables faster cell planning and rollout. See Fig. 5-Fig. 6 **Citation 5: SON Self-Configuration** **SELF-CONFIGURATION** This is the dynamic plug-and-play configuration of newly deployed eNBs. The eNB will by itself configure the Physical Cell Identity, transmission frequency and power, leading to faster cell planning and rollout. Fig. 5 Source: https://www.3gpp.org/technologies/keywords-acronyms/105-son, Page 1, Last accessed, May 27, 2020, Exhibit B **Citation 6: Self-Configuration Description** 4.3.1 General description The basic idea of Plug and Play is to avoid pre-configuration of an eNB as far as possible. In an ideal PnP world an eNB equipment is totally agnostic of its future purpose, its location in the network, its addresses, its basic configuration parameters etc... All this information is only supplied step by step during the PnP process. Fig. 6 Source:https://www.etsi.org/deliver/etsi_ts/132500_132599/132501/15.00.00_60/ts_132501v150000p.pdf, Page 10, Last accessed, May 27, 2020, Exhibit F Self-Optimization relates to the optimization of network capacity, coverage, handover, and interference in an LTE/LTE-Advance network. See Fig. 7-Fig. 8

Citation 7: SON Self-Optimization

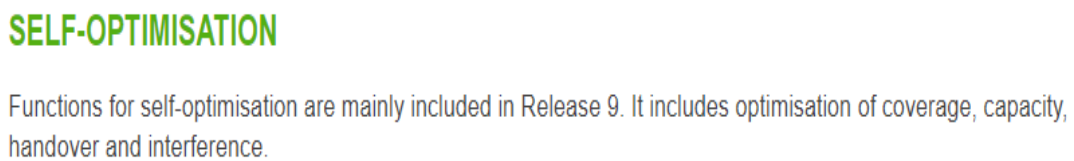


Fig. 7

Source: https://www.3gpp.org/technologies/keywords-acronyms/105-son, Page 1, Last accessed, May 27, 2020, Exhibit B

Citation 8: Self-Optimization Description

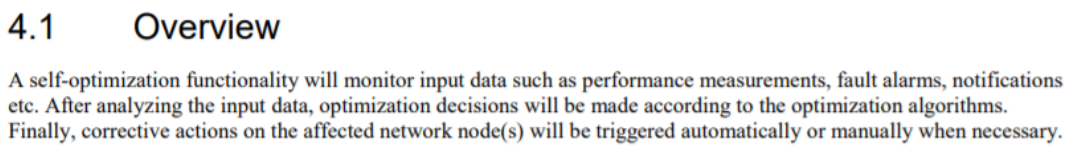


Fig. 8

Source:https://www.etsi.org/deliver/etsi_ts/132500_132599/132521/11.01.00_60/ts_132521v110100p.pdf, Page 8, Last accessed, May 27, 2020, Exhibit G

Self-Healing provides features for automatic detection and removal of failures in the network elements such as eNodeB. See Fig. 9-Fig. 10

Citation 9: SON Self-Healing

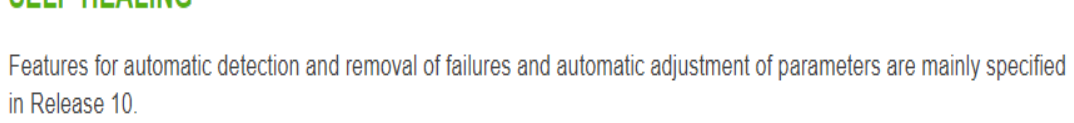


Fig. 9

		Source: https://www.3gpp.org/technologies/keywords-acronyms/105-son, Page 2, Last accessed, May 27, 2020, Exhibit B **Citation 10: Self-Healing Description** Self-healing is a functionality of SON. The purpose of Self-healing is to solve or mitigate the faults which could be solved automatically by triggering appropriate recovery actions. Fig. 10 Source:https://www.etsi.org/deliver/etsi_ts/132500_132599/132541/15.00.00_60/ts_132541v150000p.pdf, Page 8, Last accessed, May 27, 2020, Exhibit C
1a. detecting at least one of failure of a base station and addition of a base station;	As discussed herein, **observed changes** may be, for example, **failure of a network element (e.g., a Node-B** or component thereof), **addition of a new Node-B**, etc. [Col. 6, Line 49-51]	The accused product comprises provides a method for, detecting at least one of failure of a base station and addition of a base station; NEC small cell LTE gateways support multiple vendors and provide the features of self-healing and self-configuration. The self-healing feature detects failures/faults in an eNodeB (i.e. base station) and the self-configuration feature detects the addition of new eNodeB. See Fig. 11 **Citation 11: NEC Multi-Vendor SON**

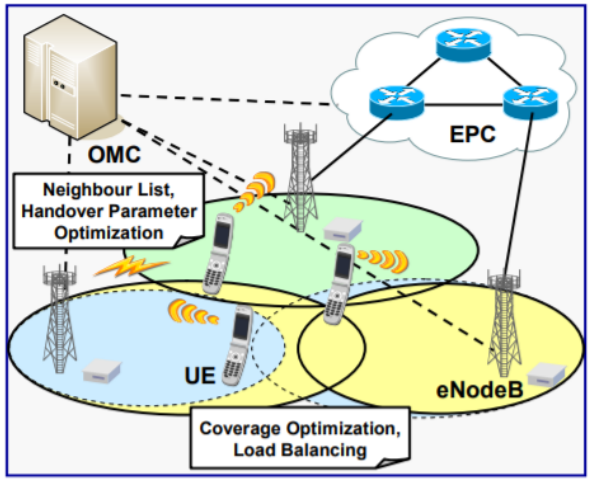
		Testing concentrated on S1 and X2 interfaces in a multi-vendor environment, such as Regression Testing, Handover, Mobility and SON. As well as testing small cell/macro cell handover and security gateways, another key area of focus was the testing of auto-tuning SON features in multi-vendor heterogeneous networks (HetNets). SON test cases were provided by the Next Generation Mobile Network (NGMN) P-SmallCells project, which is driving the development of multi-vendor SON. The test cases covered the major SON features such as self-configuration of neighbor relations, load balancing and self-optimization of mobility, coverage and capacity. Fig. 11 Source: https://www.nec.com/en/press/201408/global_20140806_01.html, Page 1, Last accessed, May 27, 2020, Exhibit E NEC small cell LTE gateways, using the NEC-SON technology, can autonomously detect multiple faults, can distinguish between temporary performance degradation and faults that occur at eNodeB (i.e. base station) such as cell outage (eNodeB failure) and can identify the root cause of the problem. See Fig. 12- Fig. 13 **Citation 12: Fault identification in NEC SON**

		• **Automated fault identification** Equipment faults are normally detected by the equipment itself autonomously. However, fault detection messages cannot always be generated or transmitted when the detection system itself is damaged. Such unidentified faults of eNodeB are commonly mentioned as sleeping cells, and they are detected by performance statistics. However, sometimes it is hard to identify the sleeping cells, since the statistics at the cell level fluctuate largely as a result of variances in traffic and radio quality. NEC's SON accurately detects the sleeping cells by doing a statistical analysis of network logs, and distinguishes eNodeB faults from temporal quality degradation by detecting specific UEs near the area where radio quality is poor. Correlating multiple alarms is also used to automatically identify the root cause of the problem. Fig. 12 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H **Citation 13: Cell outage detection in NEC SON** • **Cell outage compensation** When an equipment fault is detected, SON analyzes internal logs of the equipment, identifies the root cause, and takes some recovery actions such as fallback to the Fig. 13 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H

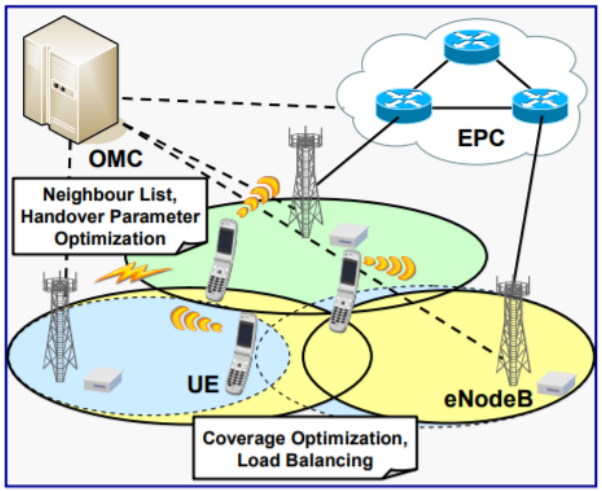
		NEC small cell LTE gateways, using the NEC-SON technology, can detect newly added cell (i.e. eNodeB) and can automatically reconfigure the neighbor list of the connected user equipment (UE). **Citation 14: Detection of a cell in NEC SON** • **Neighbor list optimization** This optimization automatically reconfigures a neighbor list so that the list contains the minimum set of cells necessary for handover. The neighbor list can be dynamically updated on the basis of UE measurement reports. For example, newly reported cells are added, and cells with very few handover attempts or frequent handover failures are removed from the list. These operations can be decided while considering operator's individual requirements managed in the OMC. Fig. 14 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H
1b. analyzing current system conditions in response to the detected failure or addition; and	As illustrated in FIG. 4, after **detecting failure of a network element** (e.g., a Node-B), the RNC 115 may **determine a current overall**	The accused product comprises a method for, analyzing current system conditions in response to the detected failure or addition; and NEC SON technology on the LTE Gateways provides the features of self-optimization and self-healing to analyze faults or the addition of new network elements in the network and

	performance level of the RAN 150, at step S402. [Col. 7, Line 1-4]	perform analysis to find the root cause of the problem or to optimize the network. See Fig. 15-Fig. 17 **Citation 15: Fault identification in NEC SON** • **Automated fault identification** Equipment faults are normally detected by the equipment itself autonomously. However, fault detection messages cannot always be generated or transmitted when the detection system itself is damaged. Such unidentified faults of eNodeB are commonly mentioned as sleeping cells, and they are detected by performance statistics. However, sometimes it is hard to identify the sleeping cells, since the statistics at the cell level fluctuate largely as a result of variances in traffic and radio quality. NEC's SON accurately detects the sleeping cells by doing a statistical analysis of network logs, and distinguishes eNodeB faults from temporal quality degradation by detecting specific UEs near the area where radio quality is poor. Correlating multiple alarms is also used to automatically identify the root cause of the problem. Fig. 15 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H **Citation 16: Cell outage detection in NEC SON**

		• **Cell outage compensation** When an equipment fault is detected, SON analyzes internal logs of the equipment, identifies the root cause, and takes some recovery actions such as fallback to the Fig. 16 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H **Citation 17: Detection of a cell in NEC SON** • **Neighbor list optimization** This optimization automatically reconfigures a neighbor list so that the list contains the minimum set of cells necessary for handover. The neighbor list can be dynamically updated on the basis of UE measurement reports. For example, newly reported cells are added, and cells with very few handover attempts or frequent handover failures are removed from the list. These operations can be decided while considering operator's individual requirements managed in the OMC. Fig. 17 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H
1c. determining if dynamic improvement is needed based on the analyzing step; and	In operation, the RNC 115 may **determine a need for dynamic improvement,** for	The accused product comprises a method for, determining if the dynamic improvement is needed based on the analyzing step; and

	example, **in response to observed changes** within a wireless network (e.g., the RAN 150 of FIG. 1). [Col. 6, Line 13-15]	According to the results of the analysis, NEC small cell LTE gateway uses the NEC SON technology and determines whether any actions are required for improvement in the network performance. The actions involve steps such as optimizing neighbor list (detection of new eNodeB), coverage and capacity optimization, mobility, and load balancing optimization (reducing handovers and ensuring load balancing), and fault identification and cell outage compensation. See Fig. 18 **Citation 18:NEC SON Self-Optimization**  Fig. 18 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H NEC SON technology allows the LTE Gateway to determine if the corrective action on the affected network node will be triggered automatically (i.e. dynamically) or manually. The

		automatic process will increase (i.e., improve) the network performance dynamically (i.e., if dynamic improvement is needed). See Fig. 19 - Fig 20. **Citation 19: Self-Optimization Description** 4.1 Overview A self-optimization functionality will monitor input data such as performance measurements, fault alarms, notifications etc. After analyzing the input data, optimization decisions will be made according to the optimization algorithms. Finally, corrective actions on the affected network node(s) will be triggered automatically or manually when necessary. Fig. 19 Source:https://www.etsi.org/deliver/etsi_ts/132500_132599/132521/11.01.00_60/ts_132521v110100p.pdf, Page 8, Last accessed, May 27, 2020, Exhibit G **Citation 20: Dynamic improvement** It is also of interest to minimise operational effort by introducing self configuring and self optimising mechanisms. A self optimising function shall increase network performance and quality reacting to dynamic processes in the network. Fig. 20 Source: https://www.etsi.org/deliver/etsi_tr/136900_136999/136902/09.03.01_60/tr_136902v090301p.pdf, Page 6, Last accessed, Sep 9, 2020, Exhibit J
1d. dynamically improving network parameters, for use during a subsequent periodic time interval,	At S302, the RNC 115 may **determine network parameters for improving** the	The accused product provides a method for, dynamically improving network parameters, for use during a subsequent periodic time interval, based on system conditions monitored for at least a first period within a previous periodic time interval if the determining step determines that dynamic improvement is needed; wherein

based on system conditions monitored for at least a first time period within a previous periodic time interval if the determining step determines that dynamic improvement is needed; wherein	RAN 150 **based on the monitored system conditions. That is, namely, the RNC 115 may determine network parameters, to be utilized during a first time period within at least one subsequent periodic time interval based on the monitored system conditions.** [Col. 5, Line 37-42] In operation, the RNC 115 may **determine a need for dynamic improvement,** for example, **in response to observed changes** within a wireless network (e.g., the RAN 150 of FIG. 1). [Col. 6, Line 13-15]	After completing the analysis, NEC small cell LTE gateway uses the NEC SON technology and determines whether any action needs to be taken. Consequently, the small cell LTE Gateway takes the necessary steps such as optimizing neighbor list (detection of new eNodeB), coverage and capacity optimization, mobility and load balancing optimization (reducing handovers and ensuring load balancing), and fault identification and cell outage compensation. See Fig. 21 **Citation 21:NEC SON Self-Optimization**  Fig. 21 Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H

		Self-optimization feature of NEC SON technology allows the LTE Gateway to monitor system status for a certain pre-defined time period (i.e., a first time period within a previous periodic time interval) as shown in Fig. 22. **Citation 22: Self-Optimization Monitoring and Management** The order of the bullet points in the list below does not imply any statements on the order of execution. [SO1] The input parameters (KPIs, Alarms, etc.) are monitored continuously. [SO2] When the monitored parameters do not meet the optimization targets, the optimization function is triggered. [SO3] Optimisation function proposes corrective actions. [SO4] Operator may confirm the execution/activation of the proposed actions if needed. [SO5] Corrective actions are executed. [SO6] Optimisation function monitors system status for a certain pre-defined monitoring time period. [SO7] The configuration prior to the corrective action is memorised if needed. [SO8] If the system status is satisfactory during the monitoring time period, then go to [SO1]. [SO9]Operator may confirm if fallback is needed. [SO10] Fallback is executed. [SO11] The operator is informed about the progress and important events occurring during the self-optimization process. Fig. 22 Source:https://www.etsi.org/deliver/etsi_ts/132500_132599/132521/11.01.00_60/ts_132521v110100p.pdf, Page 23, Last accessed, Sep 9, 2020, Exhibit G Based on the monitored parameters, if the dynamic improvement is needed, the SON self-optimizing feature allows the LTE Gateway to increase (i.e., improve) the network performance by reacting to dynamic process in the network (i.e., dynamically improving network parameters) in a time interval (i.e., subsequent periodic time interval). Fig. 22.

		Citation 23: Dynamic improvement **3.2. Self-Optimization SON** It is also of interest to minimise operational effort by introducing self configuring and self optimising mechanisms. A self optimising function shall increase network performance and quality reacting to dynamic processes in the network. Fig. 23 Source: https://www.etsi.org/deliver/etsi_tr/136900_136999/136902/09.03.01_60/tr_136902v090301p.pdf, Page 6, Last accessed, Sep 9, 2020, Exhibit J
1e. an overall performance of the wireless network is characterized by a vector having two components, one representing network coverage and another representing network capacity.	As discussed above, an **overall performance of a wireless network may be characterized by a vector with,** for example**, two components, one representing network coverage and another representing network capacity.** [Col. 6, Line 35-38]	The accused product comprises a method where, an overall performance of the wireless network is characterized by a vector having two components, one representing network coverage and another representing network capacity. The self-optimization feature of the NEC SON technology allows the small cell LTE gateways to help enhance the coverage and capacity of the LTE network, which results in improvement of the overall performance of the LTE network. See Fig. 24

Citation 24:NEC SON Self-Optimization

- **Coverage and capacity optimization**

This optimization aims at maximizing the system capacity and ensuring there is an appropriate overlapping area between adjacent cells. The optimal parameter setting is acquired by cooperatively adjusting antenna tilt and pilot power among the related cells. This optimization should operate with some effect even if the measurement reports from UE do not include their data on their own location.

Fig. 24

Source: https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf, Page 3, Last accessed, May 27, 2020, Exhibit H

In the case of LTE networks, coverage and capacity are the vectors, which are used to measure the overall performance of the network. See Fig. 25

Citation 25: Capacity and Coverage Optimization

5.4.3 Capacity and coverage optimization

Although, it is of primary interest to provide coverage to users during a roll-out, it is equally important to enhance the capacity of the network during operation. As such, both coverage and capacity are considered in the use case and supported by the SON function. The CCO SON function should be configured through appropriate objectives and targets in order to meet the operator"s requirement on coverage and capacity, and the prioritization between them.

Fig. 25

Source:https://www.etsi.org/deliver/etsi_ts/132500_132599/132521/11.01.00_60/ts_132521v110100p.pdf, Page 16, Last accessed, May 27, 2020, Exhibit G

References Cited

Exhibit(s)	Description	Link
Exhibit A	LTE SON Concepts	https://www.etsi.org/deliver/etsi_ts/132500_132599/132500/15.00.00_60/ts_132500v150000p.pdf
Exhibit B	3GPP SON	https://www.3gpp.org/technologies/keywords-acronyms/105-son
Exhibit C	LTE Self-Healing	https://www.etsi.org/deliver/etsi_ts/132500_132599/132541/15.00.00_60/ts_132541v150000p.pdf
Exhibit D	NEC LTE Gateway	https://www.nec.com/en/press/201306/global_20130621_01.html
Exhibit E	NEC Multi-Vendor SON	https://www.nec.com/en/press/201408/global_20140806_01.html
Exhibit F	LTE Self-Configuration	https://www.etsi.org/deliver/etsi_ts/132500_132599/132501/15.00.00_60/ts_132501v150000p.pdf
Exhibit G	LTE Self-Optimization	https://www.etsi.org/deliver/etsi_ts/132500_132599/132521/11.01.00_60/ts_132521v110100p.pdf
Exhibit H	NEC SON	https://www.3g4g.co.uk/Lte/LTE_SON_WP_0902_NEC.pdf
Exhibit I	NEC Small Cell LTE in US	https://www.necam.com/press/read.cfm?ID=97025c9d-17f2-4539-a2f5-422fde50cc09
Exhibit J	Self-configuring and self-optimizing network (SON)	https://www.etsi.org/deliver/etsi_tr/136900_136999/136902/09.03.01_60/tr_136902v090301p.pdf